ANNUAL RESEARCH REPORT
FY 2010
February 2010

1. <u>Title</u>:

Demographic Characteristics and Ecology of Northern Spotted Owls (*Strix occidentalis caurina*) in the Southern Oregon Cascades.

2. <u>Principal Investigators and Organizations</u>:

Dr. Katie Dugger (PI), Department of Fisheries and Wildlife, Oregon State University, Corvallis, Oregon; Biologists: S. Andrews (Project Leader), E. Fleigel, L. Friar, D. Strejc and F. Wagner, Department of Fisheries and Wildlife, Oregon State University, Corvallis, Oregon.

3. <u>Study Objectives</u>:

a. Estimate population parameters (proportion of territories where owls were detected, fecundity, survival rates, and annual rates of population change) of northern spotted owls on the Rogue River-Siskiyou and Fremont-Winema National Forests.

b. Examine northern spotted owl diets, nesting habitat, and interspecific interactions with barred owls.

c. Communicate results to other researchers examining northern spotted owl ecology.

4. <u>Potential Benefit or Utility of the Study</u>:

Studying the population dynamics, diet and habitat characteristics associated with breeding spotted owls will increase our understanding of factors affecting spotted owl populations. This study offers insights into spotted owl ecology while concurrently addressing the validation and effectiveness monitoring requirements of the Northwest Forest Plan (USDA and USDI 1994). The Southern Oregon Cascades Study Area is one of eight Federally-sponsored study areas that represent the Effectiveness Monitoring Program for Spotted Owls in the Northwest Forest Plan (Lint et al. 1999). Demography data from this study area has been included in five meta-analyses of spotted owl vital rates across the species range (Burnham *et al*. 1996, Franklin *et al*. 1999, Anthony *et al*. 2006, Forsman *et al*. 2011). These data were important for the 2004 review of the species' threatened status (USFWS 2004) and the development and current revision of the recovery plan for the northern spotted owl (USDI 2008, 2010).

5. <u>Study Description and Survey Design</u>:

The design of this project follows the framework of a demographic study that monitors a collection of known owl sites within a bounded area. To meet the objectives of this study, we gathered annual data that allowed us to estimate survival, reproductive rates, and annual rate of population change (Forsman et al. 2011). This study utilized a sample of northern spotted owls within Late-Successional Reserve (LSR), Matrix Land-use Allocations (LUA) (USDA and USDI

1994) and Wilderness Areas. We followed survey protocol and data collection procedures as outlined in Forsman (1995).

6. Study Area

The Southern Cascades Study Area incorporates approximately 2,400 km^2 of primarily Federal forest land. The area is geographically situated on lands administered by the Rogue River-Siskiyou National Forest (High Cascades Ranger District), the Fremont-Winema National Forest (Klamath Ranger District), and secondarily, owing to owl site migration, the Umpqua National Forest (Diamond Lake Ranger District), and the Lakeview District-BLM (Klamath Falls Resource Area) (Figure 1). The study area occupies the southern terminus of the Oregon Cascades including portions of both the western and eastern provinces. Landforms are primarily volcanic in origin and consist of plateaus and moderately dissected terrain (USDA and USDI 1994). The study area lies within the Mixed-Conifer, *Abies concolor*, *Abies magnifica* var. *shastensis*, and *Tsuga mertensiana* zones at elevations ranging from 900-2000 meters (Franklin and Dyrness 1973).

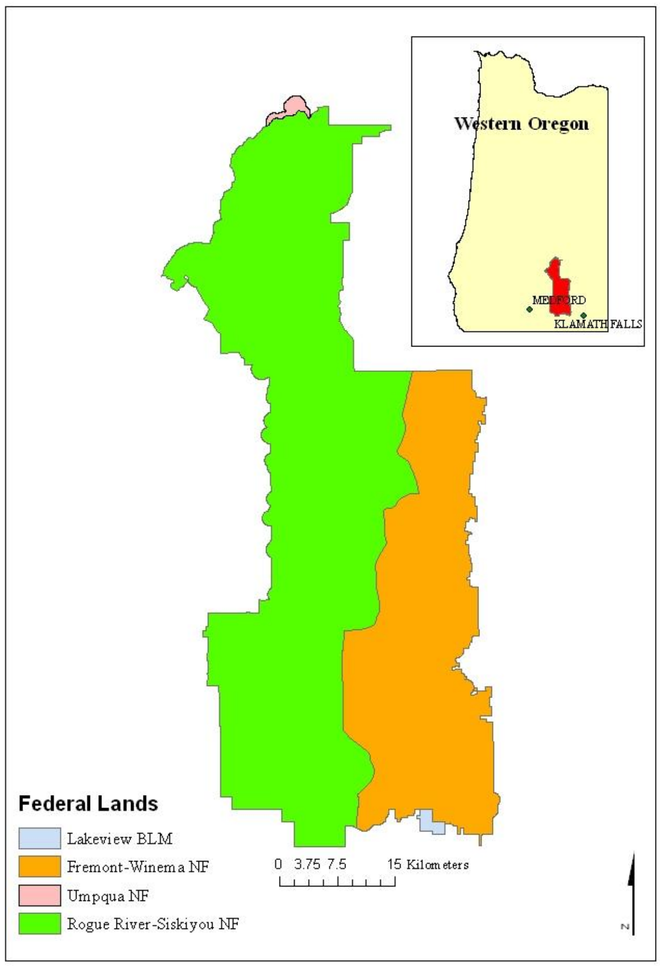

Figure 1**.** The Southern Cascades Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 1990-2010.

The Southern Cascades Spotted Owl Study Area was established in 1990 and is one of the eight long-term monitoring sites in the Effectiveness Monitoring Program for Northern Spotted Owls under the auspices of the Northwest Forest Plan (Lint et al. 1999). The total number of surveyed spotted owl sites has increased over time, as new sites are added when previously unmonitored owls are detected and a total of 170 sites were surveyed in 2010 (Figure 2).

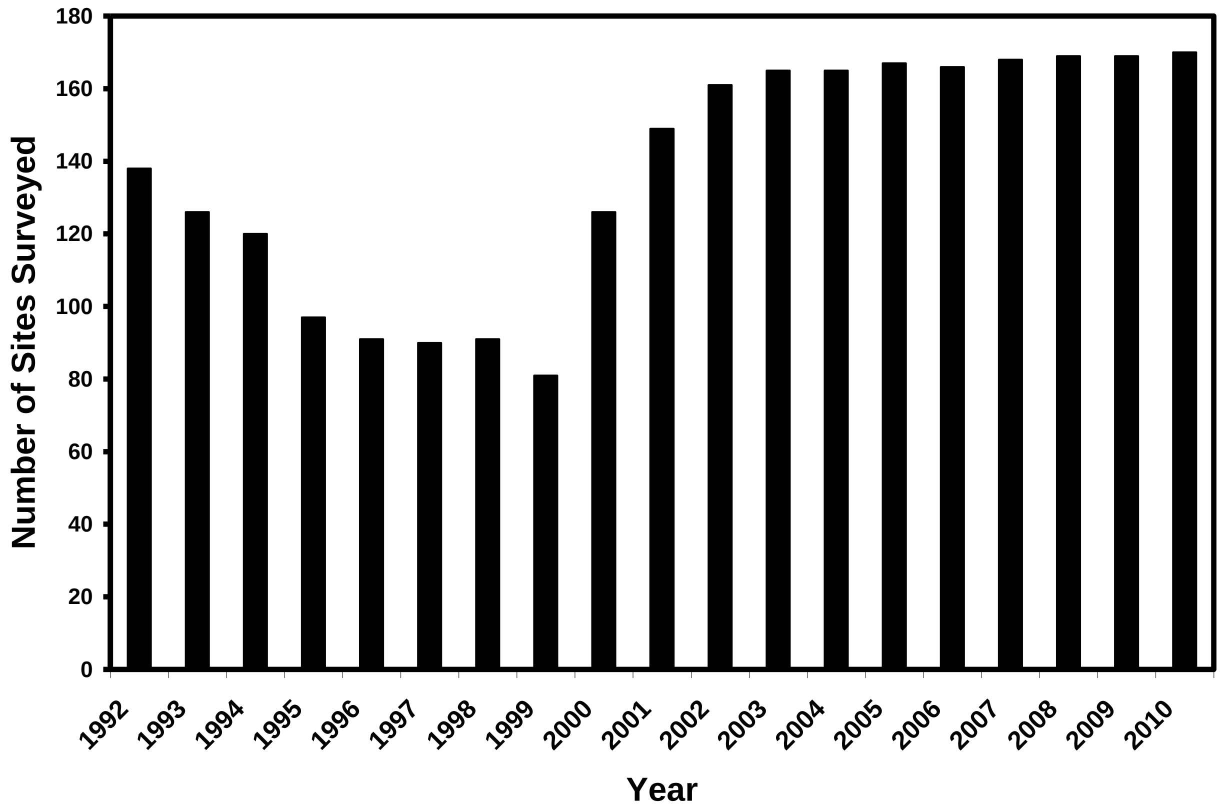

Figure 2**.** The number of historic spotted owl territories surveyed annually on the Southern Cascades Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 1992-2010.

There are 89 sites within the boundaries of the study that have been surveyed continuously from 1992 to 2010 and this subset of owl territories were among those used to estimate the annual rate of population change in the last two meta-analyses (Anthony et al. 2006, Forsman et al. 2011).

An important component of the Southern Cascades Northern Spotted Owl Study Area is the Late-successional Reserves: Rogue-Umpqua Divide (LSR 225), Middle Fork (LSR 226), Dead Indian (LSR 227), Clover Creek (LSR 228), and Sevenmile Creek (LSR 229). Of these, Rogue-Umpqua Divide, Middle Fork, and Dead Indian are large encompassing 16,050, 20,080, and 41,310 ha, respectively, and projected to support 15-20 pairs of owls (USDA 1998). Clover Creek and Sevenmile Creek LSRs are smaller, incorporating 1,130 and 3,710 ha (USDA 1997). The LSRs are situated entirely within the study area. Dead Indian LSR spans the crest of the southern Oregon Cascades and is jointly administered by the Rogue River-Siskiyou and Fremont-Winema National Forests. Three Congressionally Reserved Wilderness Areas are also located within the study area. Owl territories were found in the Sky Lakes (45,800 ha), Mountain Lakes (9,300 ha) and a portion of the Rogue-Umpqua Divide Wilderness Areas (2,064 ha) (Figure 3).

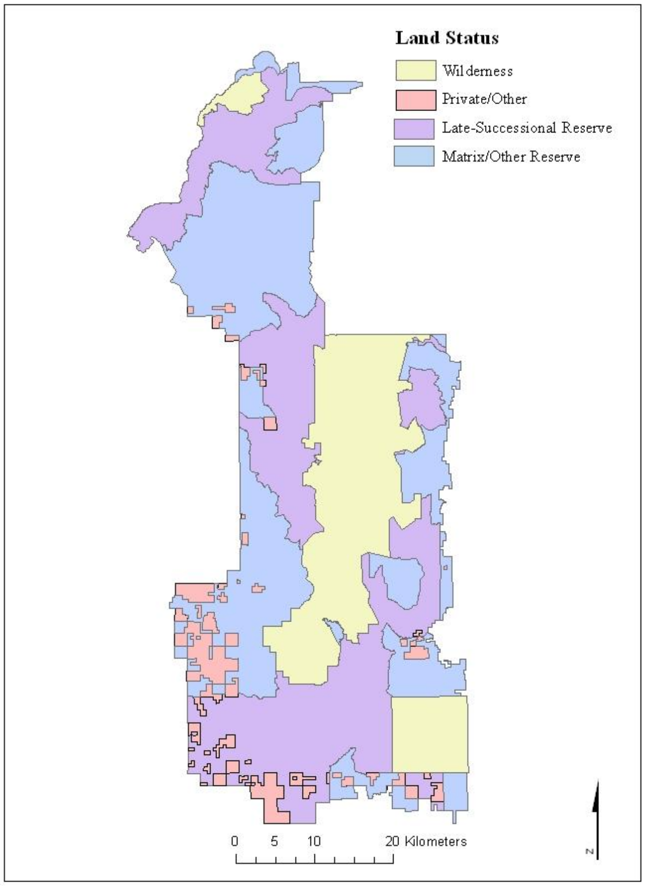

Figure 3. Land-use Allocations and owl sites within the Southern Cascades Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 1990-2010.

7. <u>Research Accomplishments</u>:

Proportion of territories where spotted owls were detected

Spotted owls were detected at 79 of the 170 sites we visited in 2010 (Figure 3). Among the sites that were surveyed, pairs were detected at 60 sites, single owls were detected at 2 sites, and owls of unknown social status were detected at 17 sites in 2010 (Appendix 1). The percentage of sites where spotted owls were detected on the study area (46.5%) represented an increase of 2% over 2009 ($\bar{x}$ = 72.8%, SE = 3.24, n = 21 years). There were 89 sites with continuous survey effort between 1992 and 2010, and banded spotted owls were detected at 41% of these sites in 2010 ($\bar{x}$ = 56.6%, SE = 2.44, n = 19 years).

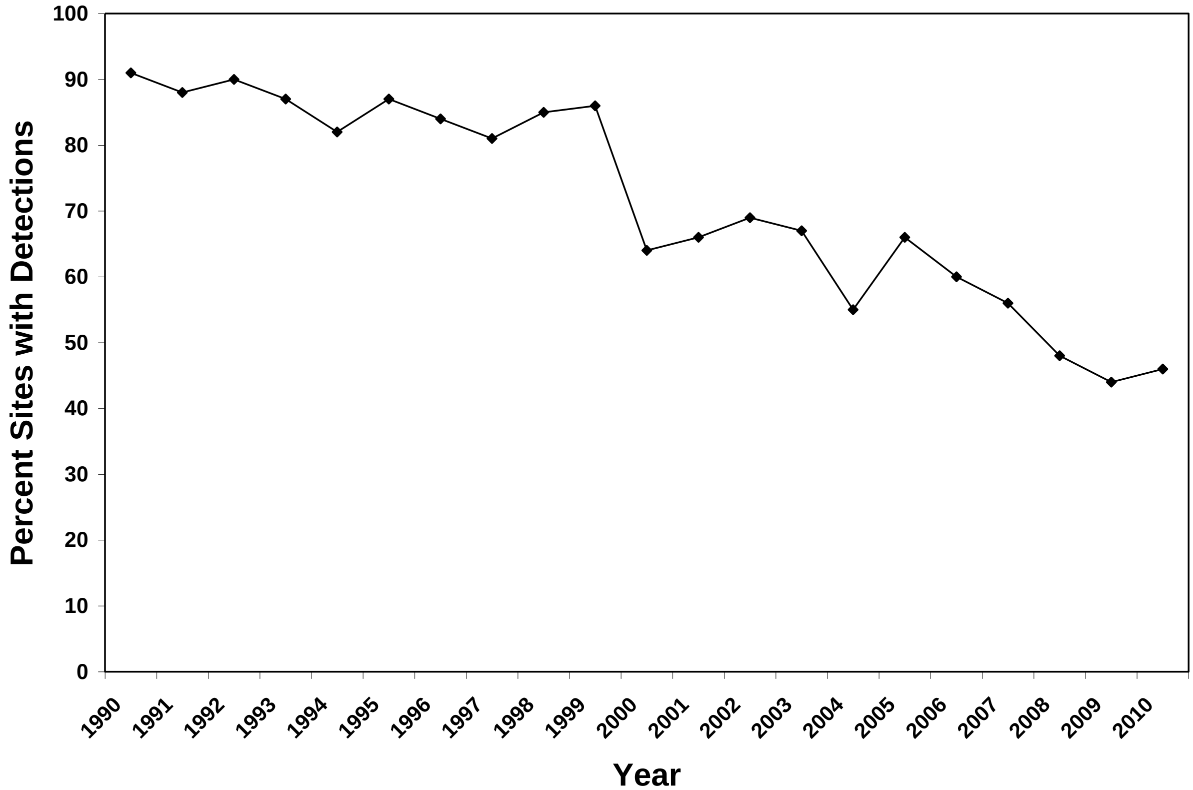

Figure 4. Percentage of all sites surveyed annually with ≥1 spotted owl detected on the Southern Cascades Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 1990-2010.

Spotted owls were detected at 7 Wilderness, 51 LSR, and 21 Matrix sites in 2010 (Appendix 2). The percentage of sites where spotted owls were detected (either single or paired) in Wilderness was 39% in 2010 ($\bar{x}$ = 62.6%, SE = 0.048, n = 14 years), and the percentage of sites where pairs were located was 28% ($\bar{x}$ = 50.2%, SE = 0.049, n = 14 years). In the LSRs, the percentage of sites where owls were detected was 52% ($\bar{x}$ = 65.3%, SE = 0.034, n = 14 years), and the percentage of sites where owl pairs were detected was 40% ($\bar{x}$ = 50.5%, SE = 0.034, n = 14 years). Owls were detected on 40% of Matrix owl territories ($\bar{x}$ = 62.1%, SE = 0.044, n = 14 years), with pairs located at 28% of sites in 2010 ($\bar{x}$ = 49.7%, SE = 0.046, n = 14 years). Overall, the mean percentage of sites with owls detected and the mean percentage of sites with pairs is very similar for the three land management categories (Appendix 2).

The number of spotted owl pairs detected in 2010 at the five LSRs was similar to most previous years. There were 14 owl pairs located in the Rogue-Umpqua Divide LSR ($\bar{x}$ = 12.7, SE = 0.69; n = 14 years; min. = 7, max. = 15). There were 12 pairs located in the Middle Fork LSR equaling 2009 ($\bar{x}$ = 11.8, SE = 0.66, n = 14 years; min. = 6, max. = 15). In the Dead Indian LSR, 12 pairs were found in 2010, three more than in 2009 ($\bar{x}$ = 14.1, SE = 1.14, n =14 years; min. = 7, max. = 20). A pair of spotted owls were located separately at the Sevenmile Creek ($\bar{x}$ = 2.79, SE = 0.33, n = 14 years; min. = 0, max. = 4) and the Clover Creek LSRs ($\bar{x}$ = 0.85, SE = 0.19, n = 13 years; min. = 0, max. = 2) in 2010.

The Northwest Forest Plan anticipated that the LSRs would provide a network of suitable habitat distributed across the range of old forest associated species sufficient to endure stochastic events resulting in localized species extirpation (USDA and USDI 1994). The large LSRs within the study area were designed to meet the objectives of the Northwest Forest Plan and be able to support 15-20 spotted owl pairs (USDA 1998). In 2010 no LSRs within the study area boundary met that objective.

Nest Success

Forty-three owl pairs were surveyed to protocol (Forsman 1995), and 33 of these pairs exhibited nesting behavior (77%). On average, 56% (SE = 5.32, n = 21 years; min. = 3%; max = 86%) of pairs detected each year attempted to nest. There were 8 nesting pairs that failed to fledge young in 2010. The mean rate of nest failure over all years (1990-2010) was 17% (SE = 1.83; min. = 0.0, max. = 26.9), but there were more nest failures than average in 2010 (25%).

Productivity

Of the sites where owls were detected in 2010, 60 pairs were located and 29 of these successfully reproduced as determined by protocol ($\bar{x}$ = 26.0, SE = 3.38, n = 21 years; min. = 1; max. = 56) (Forsman 1995). The average number of young fledged per pair (0.80) was greater in 2010 than the mean for all years ($\bar{x}$ = 0.67, SE = 0.09, n = 21 years) (Figure 5). The number of young produced per successful pair (1.66) in 2010 was similar to the average during the study ($\bar{x}$ = 1.61, SE = 0.050, n = 21 years) (Appendix 3).

In 2010, an average of 0.80 fledglings per pair were fledged in both Matrix and LSR owl sites, while 0.40 fledglings per were produced in Wilderness areas. Between 1997 and 2010 the average number of young produced per pair in Matrix ($\bar{x}$ = 0.70, SE = 0.103; min. = 0.00, max. = 1.46) and LSRs ($\bar{x}$ = 0.68, SE = 0.124; min. = 0.04, max. = 1.40) have been similar and slightly better than in Wilderness areas ($\bar{x}$ = 0.53, SE = 0.162; min. = 0.0, max. = 1.67) (Appendix 4).

Average productivity in 2010 on the Rogue-Umpqua Divide LSR was 0.71 fledglings per pair ($\bar{x}$ = 0.73, SE = 0.152, n = 14 years; min. = 0.00, max. = 1.83) with an average of 1.17 fledglings per pair ($\bar{x}$ = 0.71, SE = 0.147, n = 14 years; min. = 0.0, max. = 1.67) produced on Middle Fork LSR, and 0.83 fledglings per pair ($\bar{x}$ = 0.59, SE = 0.116, n = 13 years; min. = 0.0, max. = 1.39) on the Dead Indian LSR. Neither of the owl pairs located at the Sevenmile Creek or Clover Creek LSRs were breeding in 2010.

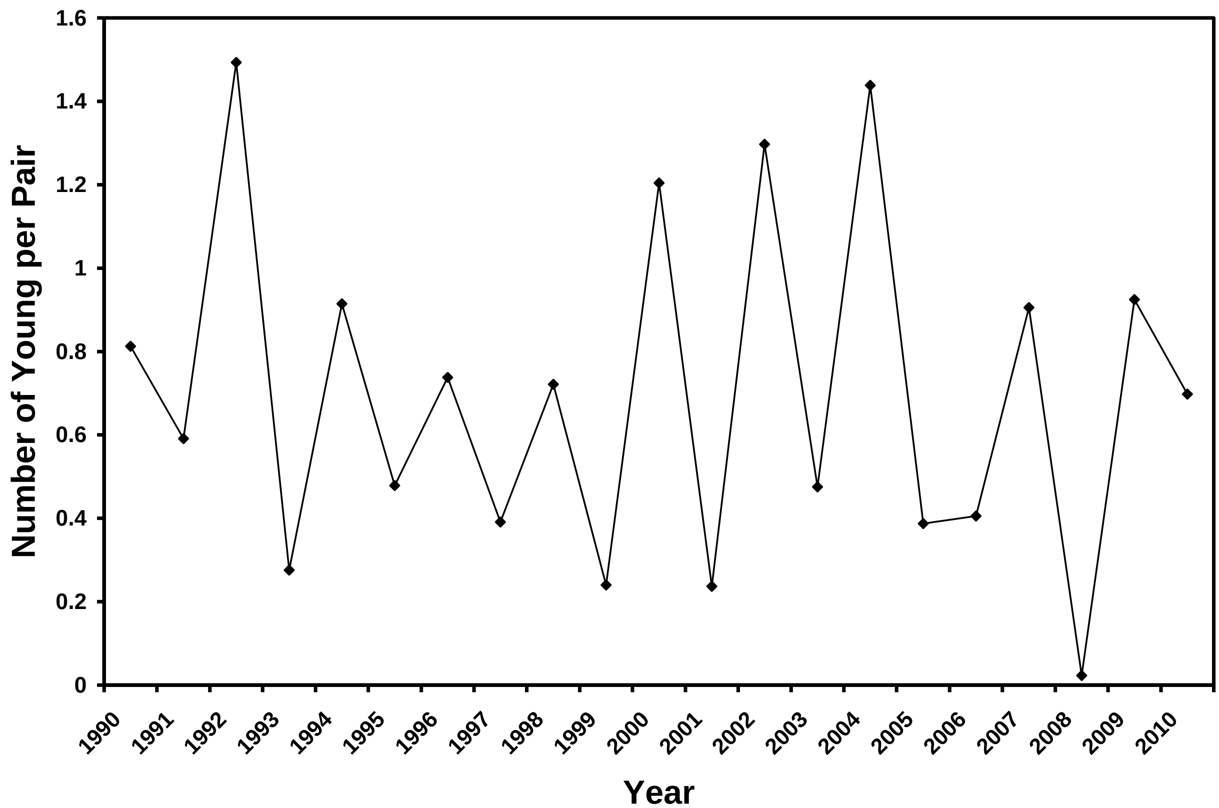

Figure 5. The number of young produced per total number of sites where spotted owl pairs were detected when surveyed to protocol for reproduction on the Southern Cascades Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 1990-2010.

We calculated fecundity as the mean number of young fledged per female checked for reproductive success divided by 2, assuming a 1:1 sex ratio of young at birth for 2010 (i.e., mean number of female young fledged per female). The mean fecundity for owl pairs we located in 2010 (age classes combined) was 0.43 ($\bar{x}$ = 0.34, SE = 0.061, n = 14 years, min. = 0.02, max. = 0.67) for territories in the LSR, 0.56 ($\bar{x}$ = 0.34, SE = 0.048, n = 14 years, min. = 0.00, max. = 0.66) for territories in the Matrix and 0.38 ($\bar{x}$ = 0.26, SE = 0.081, n = 14 years, min. = 0.00, max. = 0.67) for territories in Wilderness (Appendix 4). Over the course of the study, annual mean fecundity for spotted owl territories in the LSR and Matrix have tended to be greater than for Wilderness sites. Average fecundity was 0.39 (SE = 0.058, n = 61) across all age classes in 2010 ($\bar{x}$ = 0.34, SE = 0.046, n = 61; min. = 0.01, max. = 0.74) (Figure 6) and 0.43 (SE = 0.061, n = 57) for adults vs. 0.0 for subadults (females <3 years of age; n = 4).

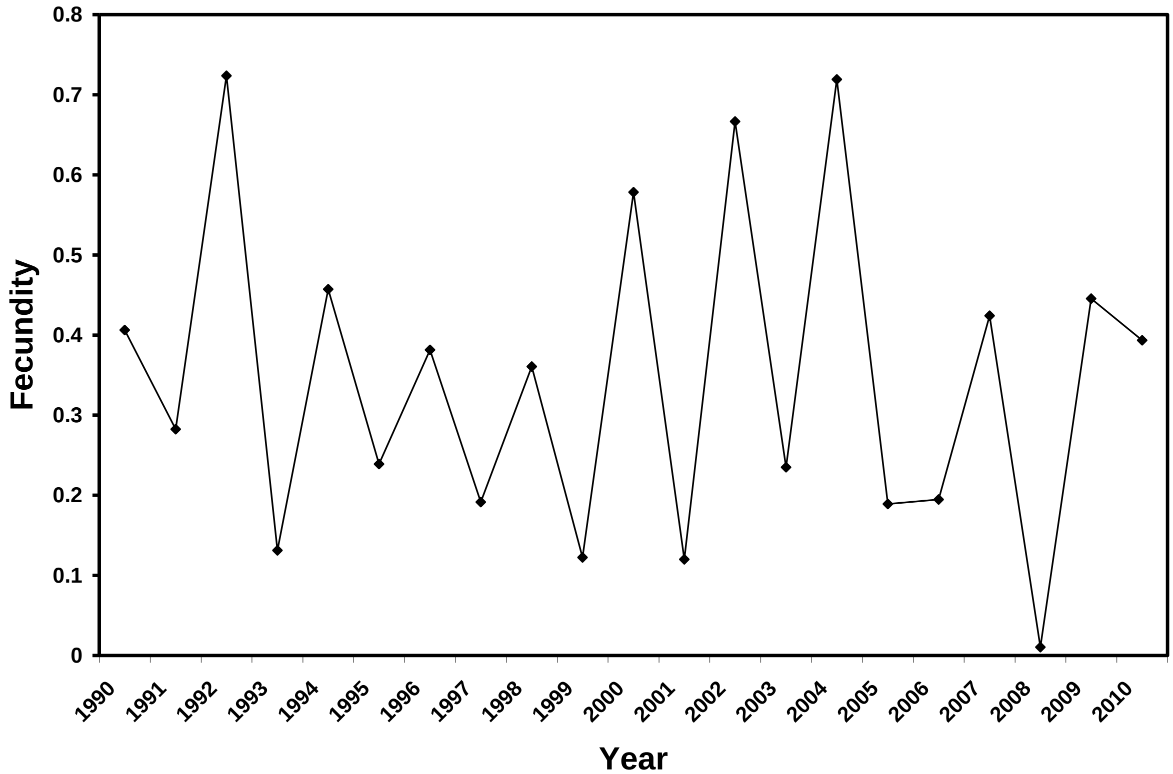

Figure 6. Mean annual fecundity (number of female fledglings per female) on the Southern Cascades Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 1990-2010.

Age and Sex Composition

In 2010, 147 non-juvenile owls were detected, which is an increase of 9% from 2009 (Appendix 5). Of the owls we could assign to an age class, 92.1% were adults (≥3 years old) and 7.9% were subadults which was greater than the study average ($\bar{x}$ = 5.26%, SE = 0.01, n = 21 years) (Appendix 5). We could not ascertain the age of 15% of the study population, which was fewer birds of unknown age than the long-term average across all years ($\bar{x}$= 18.6%, SE = 2.91, n = 21 years). The majority of unknown aged owls represented auditory detections usually during nighttime surveys without visual observation. On average 54% of the owls detected each year on the study area population are males, and males constituted a majority of the owls detected (53%) in 2010 (Appendix 5).

The total number of female and male owls appears to be declining during the study (Appendix 5). The relative proportions of female to male owls may be decreasing slightly while the number of female subadults may be increasing compared to adult females. Declines in the proportion of female owls encountered concurrent with increasing numbers of subadult females over time could indicate juvenation of the population. This could lead to lower fecundity rates, since subadults have a lower mean fecundity than adults (Forsman et al. 2011), and declines in the total number of young fledged in aggregate on the study area.

To test this possibility we modeled each owl detection from 1990 to 2010 as a binary response, using a logistic regression with 1=females and 0=males. Thus, we modeled the probability that an owl detected on our study area was a female, and we investigated whether there were any time trends, or age class effects associated with any changes in this probability. We investigated general annual time variation (t), and also a linear (T), pseudo-threshold (lnT), and quadratic (T+TT) time trend. We also investigated whether the probability of being a female in this population was related to age class (0=subadult; 1=adult). This analysis was conducted in PROC GENMOD (SAS Institute 2008), and we used an information theoretic approach to select our best models. There was evidence of a difference in the proportion of females relative to males [Akaike Weight (w_i)= 0.116, β = -0.109, SE = 0.037, 95% CI = (-0.182, -0.036)] (Akaike 1973) but this was not the best model. There was strong evidence of a greater representation of subadult females relative to the total number of females in the study population [w_i= 0.301, β = 0.294, SE = 0.149, 95% CI = (0.002, 0.587)]. There was weak support for main effects models incorporating age class with linear or pseudo-threshold time trends [β = 0.005, SE = 0.007, 95% CI= (-0.008, 0.018) and β = 0.036, SE = 0.054, 95 % CI = (-0.069, 0.141), respectively] indicating the probability of an owl being a female was stable over time (Table 1). There was little support for the interaction of time trends with the probability of a female being a subadult in pseudo-threshold [w_i= 0.057, β = 0.108, SE = 0.227, 95% CI = (-0.336, 0.552)] or linear models [w_i= 0.055, β = 0.069, SE = 0.027, 95% CI = (-0.046, 0.059)] indicating that the representation of subadult females was constant (Burnham and Anderson 2002, Anderson 2008) (Table 1).

Table 1. Model ranking of the best logistic regression models of the binary response variable sex by age representation across years for northern spotted owls on the Southern Cascades Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 1990-2010.

Model	Log Likelihood	AICc	Number of Parameters	ΔAIC	w_i
age class	-2001.0873	4006.179	2	0	0.301
age class, T[a]	-2000.8118	4007.632	3	1.453	0.146
age class, lnT[b]	-2000.8628	4007.734	3	1.555	0.138
null	-2003.0420	4008.085	1	1.907	0.116

[a]T = Linear time trend
[b]lnT = Pseudo-threshold time trend [ln(T+0.05)]

Banding and Resighting

In 2010, we banded 42 owls (29 fledglings, 4 subadults and 9 adults) on the study area and a total of 116 banded non-juvenile owls of known identity (including newly banded owls) were seen at least once during the season, which is considerably more than in 2009 (n = 103). The minimum average age for all males was 8.0 years (SE = 0.64, n = 64) and 7.8 years (SE = 0.51, n = 60) for all females. The oldest owl in the sample, banded as an adult (≥3 years old) was at least 20 years.

There were 14 documented inter-territory movements of banded owls in 2010 in the demographic study. Four non-juvenile owls banded by other cooperators outside the study area (Crater Lake National Park, Medford District BLM, and Lakeview District BLM) were located on this study area and two owls banded as juveniles on the study area were reobserved for the first time at

Crater Lake National Park. Six owls originally banded as juveniles (two in 2004 and four in 2009) and two owls banded as second-year subadults were relocated at non-natal sites within the study area in 2010.

A total of 240 movements have been recorded during 1990-2010 and the mean movement distance was 23.8 km for females (SE = 1.857, n = 115; min. = 0.9, max. = 88.0) and 15.0 km (SE = 1.431, n = 125; min. = 0.8, max. = 93.2) for males.

Barred Owls

The range of northern barred owls (*Strix varia*) has expanded during the last century and now overlaps that of the northern spotted owl (Livezly 2009). Barred owls were first detected within the boundaries of the Southern Cascades Study Area in 1981 (Pers. comm. Rick Hardy, Wildlife Biologist (Ret.), U.S. Forest Service). This study was not designed to systematically follow trends in barred owl occupancy but it has gathered a significant number of incidental detections of barred owls during the course of spotted owl surveys. The annual percentage of barred owl detections at the 170 historic spotted owl territories on the study has increased from a low of 4.1% to a high of 28.2% in 2010 (Figure 7). Cumulatively, barred owls have been detected at 63% of the spotted owl territories during at least one breeding season over the course of this study. The proportion of historic spotted owl territories where barred owls were located in 2010 increased by approximately 7% over 2009 for both the annual and cumulative totals so many of the sites where barred owls were detected in 2010 had no previously documented barred owl activity. The proportion of surveyed areas with spotted owl detections during the study exhibits a strong negative association with the proportion of surveyed areas with barred owl detections (Pearson Product-Moment $r = -0.897$, $p \leq 0.001$; SAS 2008). This proportion is likely still an underestimate of the number of spotted owl territories being influenced by barred owls, as some barred owls are likely missed during surveys for spotted owls. However, a study in the Oregon Coast range suggests that over the course of a season, spotted owl surveys to protocol ($\geq$3 visits) allow ~85% of the barred owls present in the area to be detected (Wiens et al. *In press*). In addition, we have been able to document the strong negative effects of barred owl detections on spotted owl detection rates, as well as extinction and colonization rates on this study area (Dugger et al. *In review*).

Spotted Owl Diets

A total of 4,984 prey specimens from 123 owl sites in regurgitated pellets were collected and identified between 2000-2007. Samples were collected opportunistically at spotted owl nesting or roosting sites with most pellets collected from breeding spotted owls. The sample consists primarily of northern flying squirrels (*Glaucomys sabrinus*), woodrat species (*Neotoma cinerea* and *N. fuscipes*) and Lagomorphs (Figure 8).

Pocket gophers (*Thomonys mazama and T. talpoides*), red-backed voles (*Clethrionomys californicus*) and moles (*Scapanus orarius* and *S. townsendii*) in pellets were low in biomass but higher in absolute numbers (Figure 9).

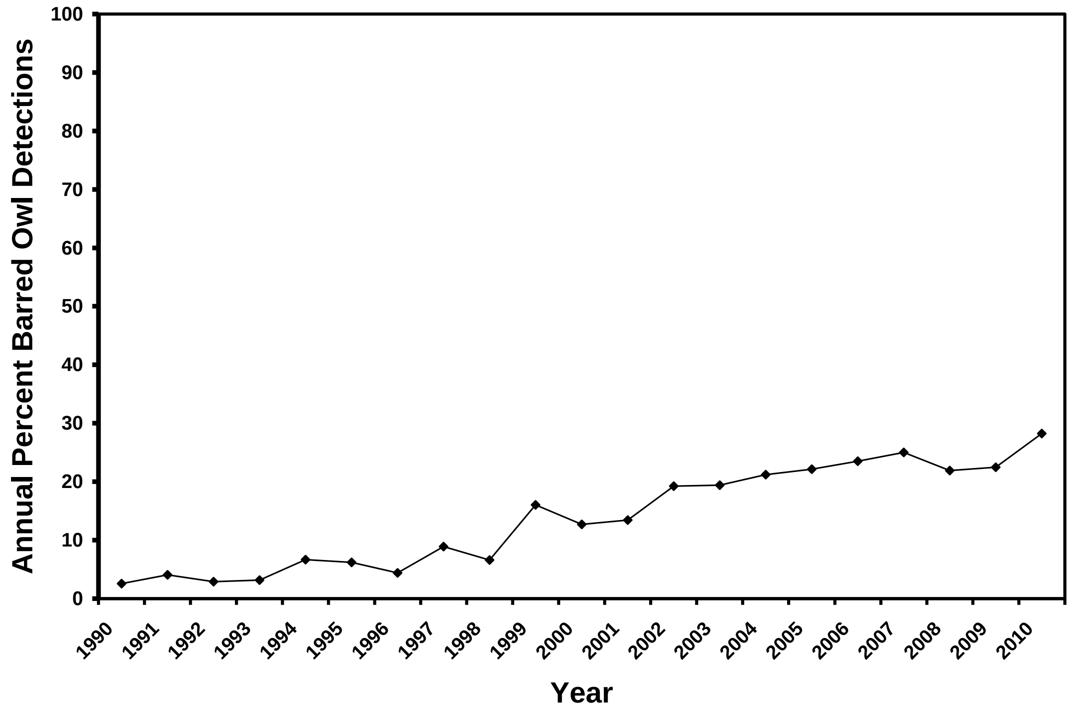

Figure 7. The annual percentages of historic spotted owl territories surveyed where barred owls were detected on the Southern Cascades Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 1990-2010.

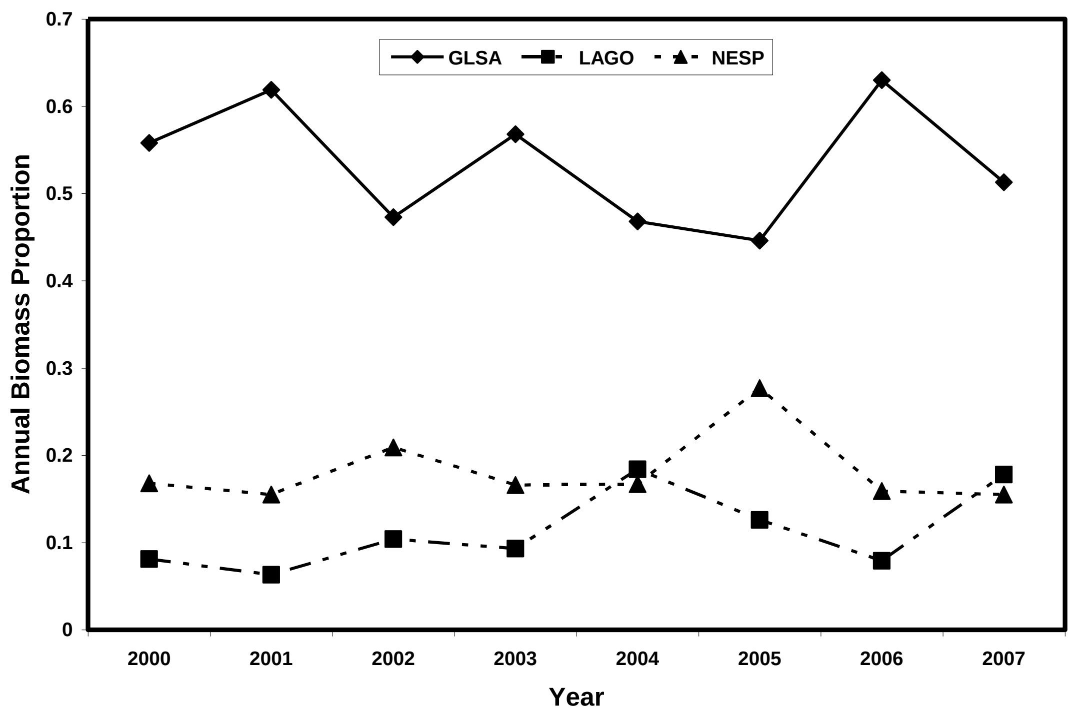

Figure 8. The annual biomass proportion of flying squirrels (GLSA = *Glaucomys sabrinus*), woodrats (NESP = *Neotoma* species) and Lagomorphs (LAGO) in regurgitated spotted owl pellets on the Southern Cascades Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 2000-2007.

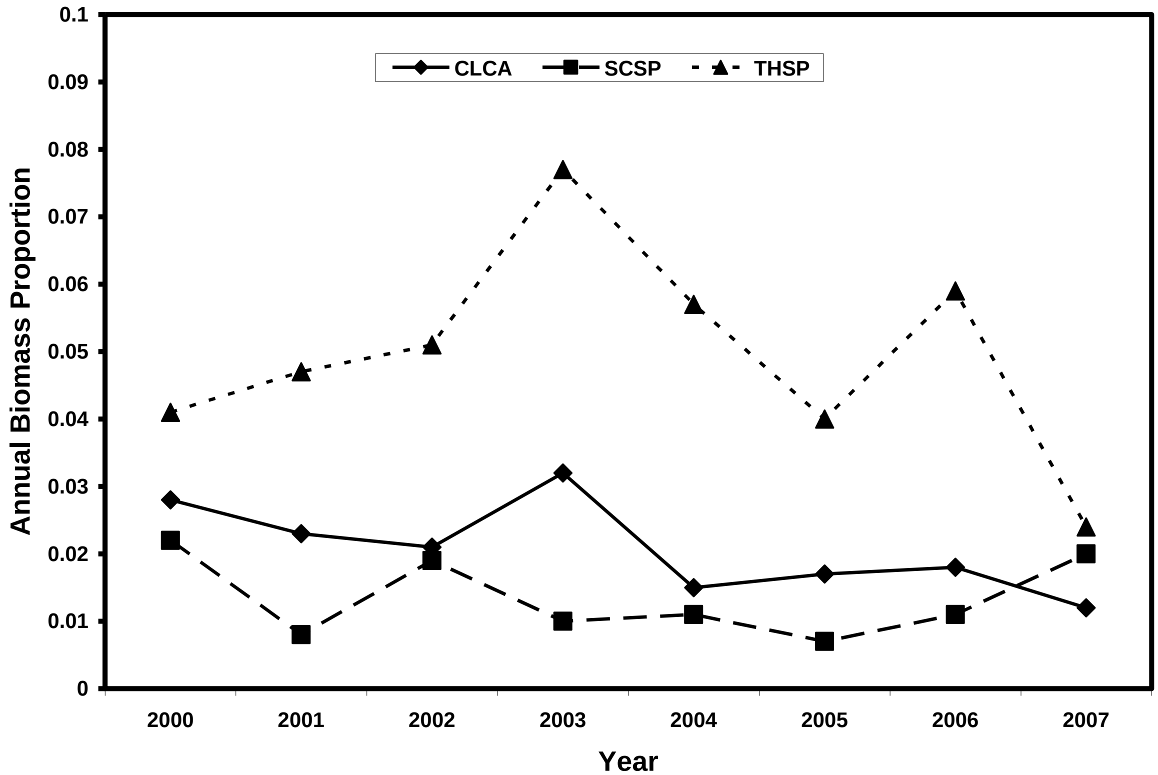

Figure 9. The annual biomass proportion of red-backed voles (CLCA = *Clethrionomys californicus*), moles (SCSP = *Scapanus* species) and pocket gophers (THSP = *Thomomys* species) in regurgitated spotted owl pellets on the Southern Cascades Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 2000-2007.

There is evidence of a relationship between the annual proportion of pairs that attempt to nest, the number of young produced per pair and the biomass proportion of several types of prey (Table 2). The proportion of pairs that attempt to nest each year was positively associated with the biomass proportion of lagomorphs (Spearman Rank: r=0.74, p=0.037; Figure 10) and negatively associated with the biomass proportion of flying squirrels (Spearman Rank: r=-0.71, p=0.047; Figure 11) (SAS 2008). This reflects the fact that when flying squirrel biomass goes down in owl diets, lagomorph biomass increases (Spearman Rank: r=-0.833, p=0.010; Table 2). Woodrats in the diet also increase when flying squirrel biomass decreases, but woodrats were not significantly associated with either the annual proportion of pairs that nest, or owl productivity (Table 2). The proportion of owl diet biomass consisting of moles (various species) was associated with the average number of young fledged per owl pair (Spearman rank r=0.683, p=0.062; Figure 12).

Table 2. Spearman rank correlations of the biomass proportion of prey items collected from spotted owl pellets on the Southern Cascades Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 2000-2007. CLCA = *Clethrionomys californicus*, GLSA = *Glaucomys sabrinus*, LAGO = Lagomorphs, NESP = *Neotoma* species, SCSP = *Scapanus* species, THSP = *Thomomys* species, PNP = the proportion of nesting pairs, NYP = the average number of young fledged per pair.

	NYP	CLCA	GLSA	LAGO	NESP	SCSP	THSP
PNP	**r^1 = 0.929** **$p^2 \leq 0.001$**	r = -0.333 p = 0.420	**r = -0.714** **p = 0.047**	**r = 0.738** **p = 0.037**	r = 0.527 p = 0.180	r = 0.551 p = 0.157	r = -0.143 p = 0.736
NYP		r = -0.191 p = 0.651	r = -0.429 p = 0.289	r = 0.595 p = 0.120	r = 0.311 p = 0.453	**r = 0.683** **p = 0.062**	r = 0.120 p = 0.779
CLCA			r = 0.500 p = 0.207	**r = -0.690** **p = 0.058**	r = 0.084 p = 0.844	r = -0.072 p = 0.866	r = 0.452 p = 0.260
GLSA				**r = -0.833** **p = 0.010**	**r = -0.683** **p = 0.062**	r = 0.048 p = 0.910	r = 0.429 p = 0.289
LAGO					r = 0.311 p = 0.453	r = 0.144 p = 0.734	r = -0.262 p = 0.531
NESP						r = -0.060 p = 0.887	r = -0.060 p = 0.888
SCSP							r = -0.204 p = 0.629

[1]Spearman correlation coefficient
[2]One-sided probability

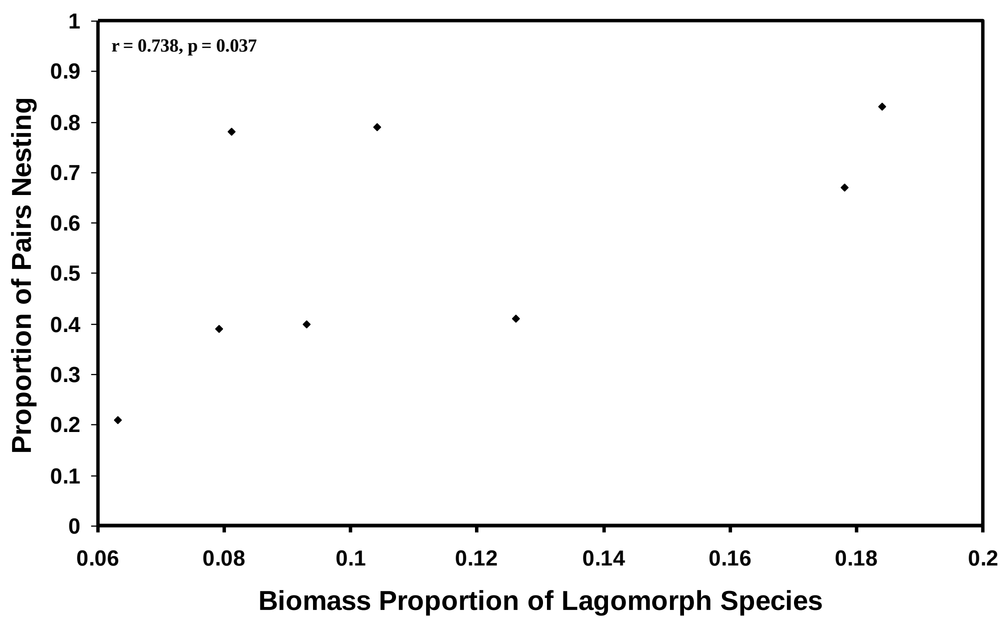

Figure 10. The annual biomass proportion of Lagomorph species and the proportion of spotted owl pairs attempting to nest as determined by protocol (Forsman 1995) on the Southern Cascades Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 2000-2007.

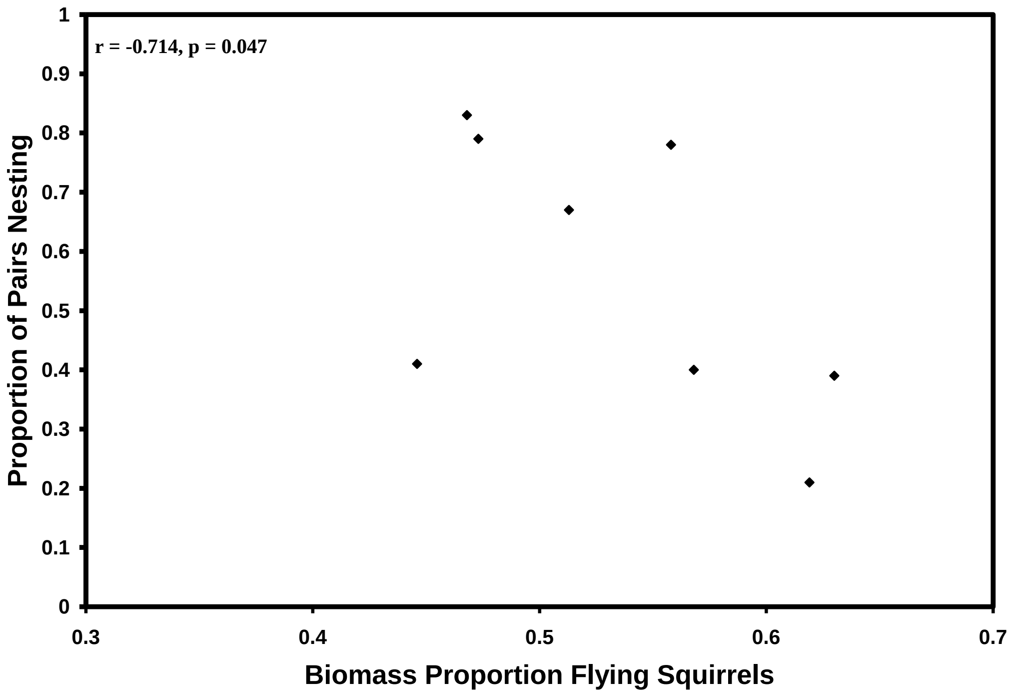

Figure 11. The annual biomass proportion of northern flying squirrels (*Glaucomys sabrinus*) and the proportion of spotted owl pairs attempting to nest as determined by protocol (Forsman 1995) on the Southern Cascades Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 2000-2007.

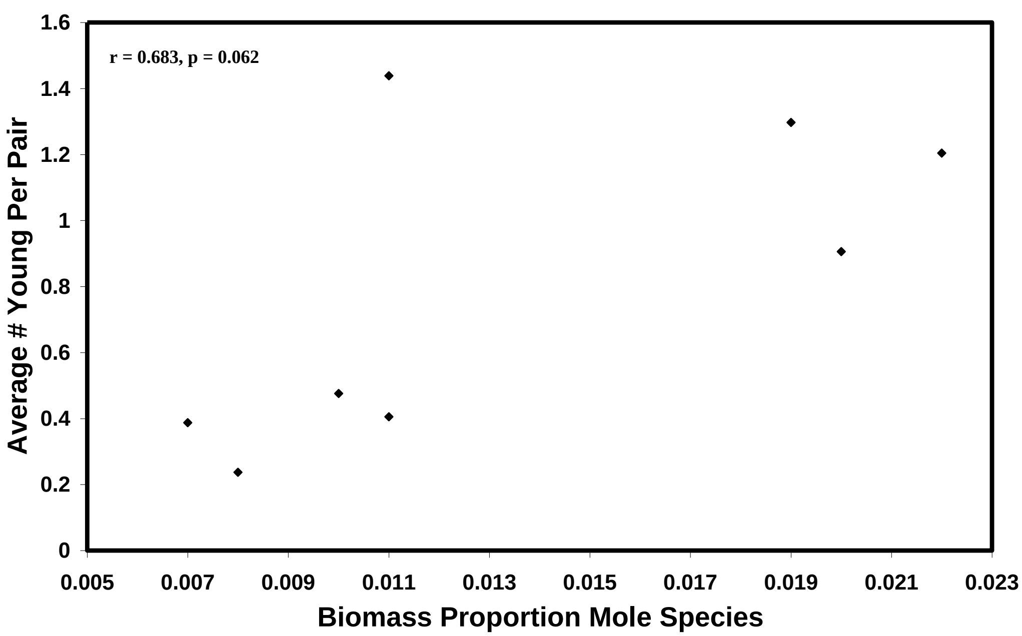

Figure 12. The annual biomass proportion of moles (*Scapanus* species) and the mean number of young per spotted owl pair as determined by protocol (Forsman 1995) on the Southern Cascades Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 2000-2007.

Survey Effort

By 1994 more than 90% of the sites currently visited in the demographic study had been identified. The number of visits conducted to spotted owl territories on the study area varies between years based on the requirements of the survey protocol relative to detecting single owls and pairs, and determining annual productivity. The majority of the visits required to determine whether an owl was present on a site are conducted as nighttime surveys. From 1994 to 2010, as the proportion of territories where owls are detected has declined, the amount of survey effort dedicated to productivity assessments has also declined and the effort for determining whether owls are present or not, has gradually increased (Figure 10). Across all visits, the proportion of nighttime surveys has doubled, increasing from 24% in 1994 to 46% in 2010 (Figure 13).

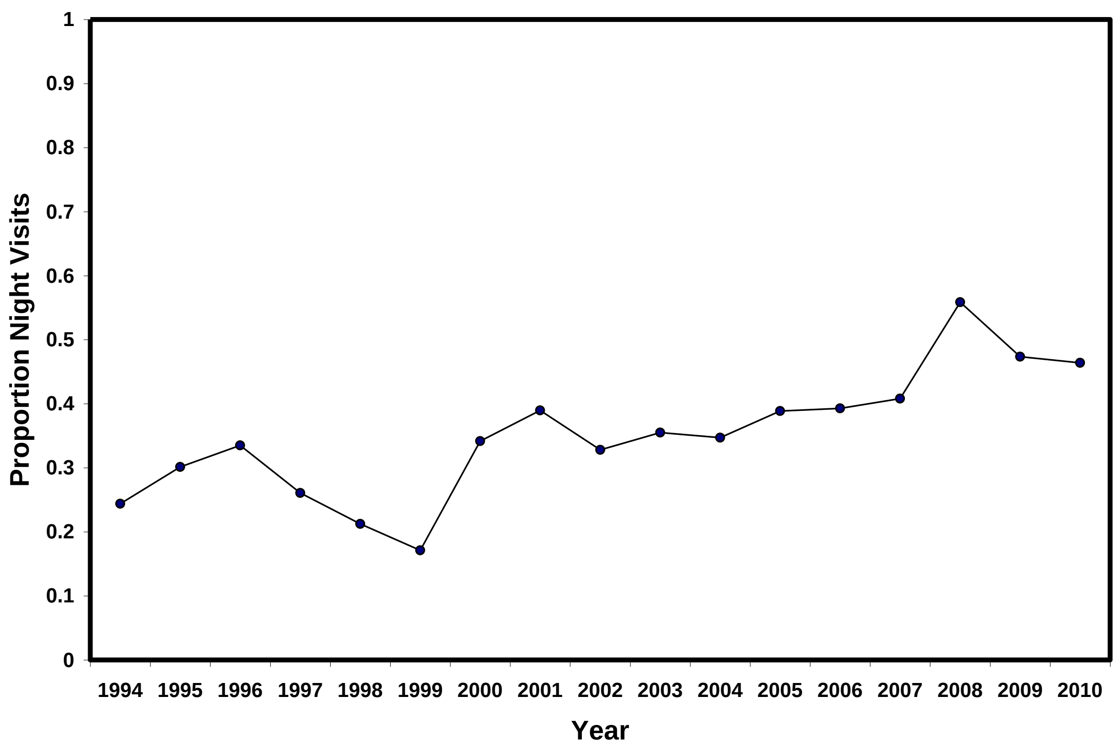

Figure 13. The annual proportion of total visits conducted as nighttime surveys of historic spotted owl territories on the Southern Cascades Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 1994-2010.

Apparent Survival, Fecundity, and Population Trend

A workshop was conducted to analyze range-wide demographic data of northern spotted owls in January 2009 (Forsman et al. 2011). The workshop was held as a requirement of the *Northern Spotted Owl Effectiveness Monitoring Plan for the Northwest Forest Plan* (Lint et al. 1999). It was the fifth in a series of demographic workshops that were convened initially in 1991 (Anderson and Burnham 1992), and again in 1993 (Burnham et al. 1996), but then every five years since 1993 (1998: Franklin et al. 1999; 2004: Anthony et al. 2006: 2009: Forsman et al. 2011). Fecundity, apparent survival, and rates of population change were estimated for the southern Oregon Cascades. To incorporate the broadest representation of color-marked spotted owls in the range of habitat types available in the southern Oregon Cascades (included spotted owls on the eastern slope of the Cascades) we incorporated a sample of spotted owls territories not reported on elsewhere in this report that are contiguous with the Southern Cascades Study Area and monitored by cooperators at Crater Lake National Park and the Klamath Falls Resource Area, Lakeview District-BLM.

This workshop expanded on the scope of previous meta-analyses by incorporating habitat and climatic/weather covariates, while also modeling demographics in relation to age, sex and barred owl detections (Forsman et al. 2011). Additionally, the annual rate of population change [lambda (λ)] was estimated as separate survival and recruitment components (Forsman et al. 2011).

Prior to the beginning of the workshop, a session was convened to establish a standardized protocol and analysis methodology following the guidelines in Anderson et al. 1999. The participants agreed to an *a priori* suite of models to be examined based on the biology of spotted owls and previous research. Survival and fecundity were estimated for all owls where sufficient data were available in the southern Cascades from 1991 to 2008. Population trend (λ) was analyzed on a sub-sample of the survival data set corresponding to 105 territories that had been surveyed continuously from 1992-2008 (89 sites on the Southern Oregon Cascades Study Area, 7 on Crater Lake National Park and 9 on the Klamath Falls Resource Area of the Lakeview District-BLM) and 57 sites that were added to the analysis in 2001 (52 sites on the Southern Oregon Cascades Study Area, 4 on Crater Lake National Park and 1 on the Klamath Falls Resource Area of the Lakeview District-BLM). This restriction was necessary because λ was estimated for owls from a fixed spatial area, (i.e., fixed group of owl territories) with a one-time only addition of sites to the original data permitted to accommodate increases in study area effort over time.

A suite of 44 models using Cormack-Jolly-Seber (CJS) estimators in program MARK was used to investigate age-specific apparent survival with time-trends for 555 non-juvenile spotted owls (Table 3) (White and Burnham 1999). Model selection was conducted using QAIC, a modification of Akaike's Information Criteria, to adjust for overdispersion (extra binomial variation) in the capture-recapture data (Akaike 1973, Burnham and Anderson 2002). The best model for survival on our study area {ϕ((S1=S2,A)+TT) p(t)}, indicated that there were no sex related differences but that subadult survival differed from survival of adult owls, and survival exhibited a quadratic time trend (T + TT) (Forsman et al. 2011). Detection probabilities also varied annually (t) (Forsman et al. 2011). However, six models were all within 2.0 ΔQAIC of the best model, so there was support for competing models (Table 3; Forsman et al. 2011). Mean apparent annual survival was estimated using model averaging, which produced estimates of 0.692/0.697 for first year subadults, 0.733/0.737 for second year subadults and 0.851/0.853 for adults (female/male, respectively; Forsman et al. 2011). Overall, annual survival appears to be declining in the southern Oregon Cascades, and this decline accelerated between 2003-2008. Neither the proportion of territories where barred owls were detected on the study area [β = 1.657, SE = 0.878, 95%CI = (-0.062, 3.378)] or reproduction [β = -0.129, SE = 0.194, 95%CI = (-0.509, 0.252)] appeared to influence spotted owl survival on our area, although there was support for a negative effect of barred owls on survival in the meta-analysis, across all study areas (Forsman et al. 2011).

Annual fecundity was estimated for 1,281 paired females from 1991 to 2008 and PROC MIXED in program SAS (SAS Institute 2008) was used to generate age-specific estimates of fecundity

(Forsman et al. 2011). The model with the most support {A+EO+ENT+HAB1} incorporated a three age-class effect, a odd-even year effect, and increasing productivity associated with both higher early nesting season temperature and greater percentages of suitable habitat within a 2.4 km radius of the annual site center (Forsman et al. 2011). There were no competing models within 2.0 ΔQAIC of the best model and fecundity for adult females was 0.35 (SE = 0.052, n = 1,176), 0.21 (SE = 0.064, n = 68) for 2-year-old subadult females, and 0.06 (SE = 0.038, n = 37) for 1-year-old subadult females (Forsman et al. 2011). Of the models containing a time trend, the best model (A + EO + T) suggested that fecundity was declining for spotted owls on the southern Cascades as the regression coefficient was negative and 95% confidence limits on the coefficient did not include zero [β = -0.015, SE = 0.005; 95% CI = (-0.026 to -0.004)]. The best model containing a barred owl effect {A + EO + BO} was not within 2.0 ΔQAIC of the best model, but the regression coefficient was negative and 95% confidence limits did not include zero [β = -0.972, SE = 0.387, 95% CI = (-1.752 to -0.193)] indicating that lower spotted owl fecundity was associated with increased barred owl detections on the southern Oregon Cascades (Forsman et al. 2011).

The rate of population change (λ) was estimated using a reparameterized Jolly-Seber (RJS) method in program MARK (λ_{RJS}) with capture-recapture data from 526 non-juvenile spotted owls (Pradel 1996, Nichols and Hines 2002). The best model for the southern Cascades {(φ(t) *p*(t) *f*(t)):RE(.)} did not include any random effects and while the point estimate was <1.0, the 95% confidence limits suggested the population was stationary during the period of the study [λ = 0.982, SE = 0.030, 95% CI = (0.923 to 1.040)] (Forsman et al. 2011). The annual realized rate of population change ($\Delta\lambda$) exhibited large annual fluctuations, but confidence limits broadly overlapped zero, also supporting the conclusion the population was stable (Forsman et al. 2011). The survival component of $\hat{\lambda}$ showed substantial temporal variation which indicated that it played an important role in population fluctuations of spotted owls in the southern Oregon Cascades.

Table 3. Model selection results including deviance, quasi-Akaike's information criteria corrected for small sample size ($QAIC_c$), ΔQAICc (the difference between $QAIC_c$ of current model and model with lowest $QAIC_c$), the number of parameters (K) and Akaike's weight (w_i) for survival models within 2.0 ΔQAIC of the best model for non-juvenile northern spotted owls in the southern Cascades, Oregon, 1991-2008.

Model	Deviance	QAIC*c*	$\Delta QAIC_c$	*K*	w_i
{φ([(S1=S2)+A]+T+TT) *p*(t)}	1805.402	4185.395	0.0000	21	0.15212
{φ([(S1=S2)+A]+T+TT) *p*(s+t)}	1804.120	4186.151	0.7563	22	0.10422
{φ([(S1+ S2+A]+T+TT) *p*(t)}	1804.508	4186.539	1.1444	22	0.08584
{φ([(S1= S2)+A]+s+T+TT) *p*(t)}	1804.898	4186.929	1.5340	22	0.07065
{φ([(S1+S2+A]+T+TT) *p*(s+t)}	1803.231	4187.301	1.9064	23	0.05864
{φ([(S1 = S2)+A]+cubic spline) *p*(t)}	1803.319	4187.389	1.9945	23	0.05612

For additional information regarding the methodology and results of the 2009 meta-analysis please see Forsman et al. 2011.

Discussion

Field work was affected somewhat by precipitation and snowpack in the south Cascades that persisted longer than normal in 2010 as the area experienced a wet cool spring. We had limited access to upper elevation sites until late May and this likely reduced our survey effectiveness relative to drier and warmer years. These climatic factors also likely introduced additional temporal variation into detections of spotted owls and assessments of productivity and survival relative to other field seasons.

The proportion of nesting attempts and the total number of previously banded birds (known identity owls) increased in 2010 compared to 2009. The increase in the number of previously banded owls may reflect the generally higher proportion of nests that failed in 2009, because if this higher failure rate was consistent across the egg-laying and incubation period, we may have missed some owl pairs that had nested briefly and failed early in the breeding season before they were located. In addition, more sites were classified as "underdermined" social status in 2010 and so more pairs may have been present on the study area than we were able to identify by survey protocol given weather induced constraints. The total percentage of sites were owls were detected (46%) was only slightly better than in 2009, and still one of the lowest percentages recorded for this study.

The reason for the higher nesting failure rate that we documented in 2009 relative to 2010 is unclear. In 2009 productivity was slightly higher than in 2010 even though the nest failure rate was higher, but this would be predicted given the climate relationships noted for productivity on our study area. Lower levels of precipitation and warmer temperature in the early nesting season are both associated with increased productivity in the southern Cascades (Dugger et al. 2006, Forsman et al. 2011). Additionally, barred owls are known to have disrupted spotted owl nesting at individual territories on the study area but in 2009 there were fewer barred owls detected than in 2010 so it seems reasonable that barred owls may not have been a primary factor contributing to the increased nest failures of 2009.

The greater representation of territorial subadult females among all female owls compared to that of subadult males in the population might indicate that fewer adult females are available to pair with resident males or recolonize vacant territories. While subadult females have lower survival and fecundity than adult females (Forsman et al. 2011), young female spotted owls appear to reach their highest reproductive output relatively early in adulthood in other portions of the species range (Loschl 2008). A shift in the age class structure of the population could make spotted owl recovery more problematic. However, there does not appear to be a time trend for an increase in the representation of subadult females at this point in time.

Through the course of the study productivity has followed a strong biannual pattern of alternating high and low years, which was disrupted by low productivity in both 2005 and 2006. The 2010 breeding season was similar to the 2009 breeding season so productivity continued to depart from the historic biannual pattern observed until recently.

The 2009 workshop and additional analyses can be synthesized in a review of the information specific to the spotted owl population in the southern Oregon Cascades. The apparent decline in the number of spotted owls has been attributed to different spatial and temporal factors including habitat loss and competition by barred owls (Forsman et al. 2011, USDI 2010). Since our surveys do not target barred owls specifically there may be more sites occupied by barred owls than we identified, and conversely spotted owls may have gone undetected where barred owls were present. However, recent a recent study has suggested that the probability of detecting a barred owl if it's present at a site, across an entire season, with at least three surveys conducted for spotted owls is relatively high (86%; Wiens et al. *In press*). In addition, a recent occupancy analysis for a subset of spotted owl territories within the study area during the time frame from 1991 and 2006 reported that the presence of barred owls at a specific site increased the probability site extinction and decreased site recolonization by spotted owls (Dugger et al. *In review*). The best models incorporating the barred owl covariate from the meta-analysis indicated some support for decreased survival and fecundity in association with an increased proportion of sites where barred owls were detected on this study area (Forsman et al. 2011).

Habitat did not appear to directly influence spotted owl survival and fecundity on the Southern Oregon Cascades study area between 1991-2003 (Dugger et. al. 2006). However, the amount of older forest surrounding spotted owl annual core areas was associated with increased survival and fecundity across all study areas in the recent meta-analysis, which incorporated a longer time series (through 2008; Forsman et al. 2011). Different map products were used to characterize habitat in these two studies, but a subset of the data used in Dugger et al. (2006) to investigate the effects of habitat on occupancy dynamics and greater amounts of habitat in owl cores as well as reduced fragmentation were associated with increased colonization rates and reduced extinction rates of spotted owl territories in the south Cascades (Dugger et al. *In review*). It's most likely that habitat characteristics affect occupancy rates more strongly than subsequent survival and productivity, and it required the increased power of the meta-analysis across multiple study areas to document this relationship. A range-wide habitat suitability map for northern spotted owls has recently been developed, which may facilitate our understanding of habitat and demographics for spotted owls across their range (Davis 2011).

Climatic and weather effects in the southern Cascades were incorporated in demographic analyses by Dugger et al. (2006), Glenn (2009), Glenn et al. (2010) and in the 2009 meta-analysis (Forsman et al. 2011). These analyses have all noted some relationship between climate and one or more demographic parameters, but the climate variables found to be important have varied by analysis. Early nesting season precipitation tended to reduce productivity on the west side of the Cascades (Dugger et al. 2006), while higher early nesting season temperatures were associated with increased productivity (Forsman et al. 2011). In addition, a quadratic relationship between annual precipitation and productivity where the number of young fledged decreased following years of less than or greater than normal precipitation has also been observed (Glenn et al. 2010). Fewer relationships between climate and survival have been reported for the south Cascades, however, annual survival was positively associated with higher winter temperatures and years with average winter storm frequency, but negatively associated with the number of days with temperatures $>90^{o}$F (Glenn et al. 2010). The separate survival and recruitment components were also related to climate, with survival negatively associated the number of days with temperatures $>90^{o}$F (hot summers) and recruitment highest two years after years with higher than average precipitation (lag effect) (Glenn et al. 2010). Thus, while climate seems to have a consistent effect on productivity, and possibly survival in the south Cascades, the climate variable that best reflects these effects is still unclear.

Whereas the direct effect of climate on productivity in particular has been hypothesized (i.e., negative effects on thermoregulation of young), climate has also been considered a proxy for fluctuations in annual prey abundance. We observed significant associations between the proportion of nesting pairs and the biomass of several prey items in spotted owl diets. Interestingly, some of these relationships reflected negative correlations between prey items such that when the proportion of flying squirrels in the diet were lower, the proportions of rabbits and woodrats in the diet increased. However, this may reflect the bias associated with the prey types brought back to owls during seasons when they nest. During seasons with higher numbers of breeding birds, more owl pellets are collected under nest trees and these pellets reflect the diets of nestlings. If larger prey items (lagomorphs, woodrats, etc.) are brought back to the nest more often than smaller prey, which the adult owl may eat while still away from the nest, this relationship between proportion of breeding pairs and annual diet proportions may actually reflect sampling bias, rather than true diet shifts. Owl productivity was positively associated with the proportion of mole biomass in the diet, but the proportion of diet biomass attributed to moles was very low and may not actually be important to owl productivity, or could again represent some sort of sampling bias.

9. Acknowledgments:

We would like to acknowledge and give special thanks to Robert Anthony (Professor Emeritus, Dept. of Fisheries and Wildlife, Oregon State University) for his years of exemplary service in the field of Wildlife Ecology; his many contributions to this study during his years as the Principle Investigator and more generally his dedication to the conservation of northern spotted owls represents a great body of original work in a very distinguished career. Many other individuals have also contributed to the success of this project, including: Dave Clayton (Forest Wildlife Biologist, Rogue River-Siskiyou National Forest), Eric Forsman (Wildlife Biologist, Pacific Northwest Research Station), Steve Hayner (Wildlife Biologist, Klamath Falls Resource Area, Lakeview District BLM), Greg Holm (Wildlife Biologist, Crater Lake national Park), Cascade Zone, Rogue River-Siskiyou National Forest), Dave Roelofs (Wildlife Biologist, Butte Falls Resource Area, Medford District BLM), Jen Sanborn (Wildlife Biologist, South Zone, Fremont-Winema National Forest) and Jeff von Kienast (Wildlife Biologist, Cascade Zone, Rogue River-Siskiyou National Forest). We also thank the Rogue River-Siskiyou and Fremont-Winema National Forest Supervisors Offices', the Regional Office of the U.S. Forest Service, and the Klamath Falls, Roseburg, and the Portland Offices' of the U.S. Fish and Wildlife Service for their support. We gratefully acknowledge the coordination of survey effort by Crater Lake National Park and the Klamath Falls Resource Area and their contributions to the 2009 Meta-analysis.

10. Research Plans for FY 2011:

a. Continued monitoring effort in preparation for the next meta-analysis of spotted owl demographic rates.

b. Continue the collection of pellets and analysis of spotted owl diets.

c. Continue the collection of data on northern spotted owl nest trees/nest sites.

d. Continue to assist personnel from Crater Lake National Park with their banding program.

11. <u>Technology Transfer Completed in FY 2010</u>:

a. K. Dugger and S. Andrews participated in data coordination efforts with personnel from other demographic studies.

b. Project personnel provided the USDA-USFS Ranger Districts, USDI-BLM Resource Areas, and USDI-Crater Lake National Park with information in preparation of the meta-analysis workshop and have coordinated surveys.

12. <u>Duration of the Study</u>:

a. Initiated in 1990.

b. This project is part of the long-term Northern Spotted Owl Effectiveness Monitoring Program for the Northwest Forest Plan (Lint et al. 1999).

13. <u>Literature Cited</u>:

Akaike, H. 1973. Information theory and an extension of the maximum likelihood principle. Page 267-281 *in* B.N. Petrov and F. Csaki, editors. Second International Symposium on Information Theory. Akademiai, Budapest, Hungary.

Anderson, D.R., K.P. Burnham, A.B. Franklin, R.J. Gutierrez, E.D. Forsman, R.G. Anthony, G.C. White, and T.M. Shenk. 1999. A protocol for conflict resolution in analyzing empirical data related to natural resource controversies. Wildlife Society Bulletin 27, 1050-1058.

Anderson, D.R. 2008. Model based inference in the life sciences, Springer-Verlag, New York, NY.

Anthony, R.G., E.D. Forsman, A.B. Franklin, D.R. Anderson, K.P. Burnham, G.C. White, C.J.Schwarz, J. Nichols, J. Hines, S.H Ackers, L.S. Andrews, B.L. Biswell, P.C. Carlson, L.V. Diller, K.M. Dugger, K.E. Fehring, T.L. Fleming, R.P. Gerhardt, S.A. Gremel, R.J. Gutierrez, P.J. Happe, D.R. Herter, J.M. Higley, R.B. Horn, L.L. Irwin, P.J. Loschl, J.A.Reid, and S.G. Sovern. 2006. Status and trends in demography of Northern Spotted Owls, 1985-2003. Wildlife Monographs No. 163: 1-48.

Burnham, K.P. and D.R. Anderson. 2002. Model selection and multi-model inference: A practical information-theoretic approach, 2nd Ed., Springer-Verlag, New York, NY.

Davis, R.J., technical coordinator. 2011. Northwest Forest Plan–status and trend of northern spotted owls from 1994 to 2008. On file with: U.S. Department of Agriculture, Forest Service, Pacific Northwest Region, 333 SW First Ave, Portland, OR 97204

Dugger, K., R. Anthony, F. Wagner, and S. Andrews. 2006. Modeling apparent survival and reproductive success of Northern Spotted Owls relative to forest habitat in the southern Cascades of Oregon. Oregon Cooperative Fish and Wildlife Unit., Corvallis, Or. 46pp.

Dugger, K., R. Anthony, and S. Andrews. *In review*. Transient dynamics of invasive competition: barred owls, spotted owls, habitat composition, and the demons of competition present. Ecology. 40 pp.

Forsman, E.D. 1995. Appendix A: Standardized protocols for gathering data on occupancy and reproduction in spotted owl demographic studies. Pp. 32 - 38 *in* J. Lint, B. Noon, R. Anthony, E. Forsman, M. Raphael, M. Collopy, and E. Starkey. 1999. Northern spotted owl effectiveness monitoring plan for the Northwest Forest Plan. U. S. Forest Service Gen. Tech. Rep. PNW-GTR-440. 43p.

Forsman, E.D., R.G. Anthony, K.M. Dugger, E.M. Glenn, A.B. Franklin, G.C. White, C.J. Schwartz, K.P. Burnham, D.R. Anderson, J. E. Nichols, J.E. Hines, J.B. Lint, R.J. Davis, and others. 2011. Demographic trends of Northern Spotted Owls, 1985-2008. Wildlife Monographs *in Press*. University of California Press. 197pp.

Franklin, J.F. and C.T. Dyrness. 1973. Natural vegetation of Oregon and Washington. Oregon State University Press, Corvallis. 417p.

Glenn, E.M. 2009. Local weather, regional climate, and population dynamics of northern spotted owls in Washington and Oregon. PhD Dissertation, Oregon State University, Corvallis, OR, USA.

Glenn, E.M., R.G. Anthony, and E.D. Forsman. 2010. Population trends in northern spotted owls: Associations with climate in the Pacific Northwest. Biological Conservation. 143: 2543-2552.

Kelly, E.G., E.D. Forsman, and R.G. Anthony. 2003. Are barred owls displacing spotted owls? Condor 105:45-53.

Lint, J.B., B.R. Noon, R.G. Anthony, E.D. Forsman, M.G. Raphael, M.I. Collopy and E.E. Starkey. 1999. Northern spotted owl effectiveness monitoring plan for the Northwest Forest Plan. U.S. Department of Agriculture - Forest Service. Gen. Tech. Rpt. PNW-GTR-444. 43p.

Livezey, K.B. 2009. Range expansion of barred owls, part I: chronology and distribution. American Midland Naturalist 161:49-56.

Loschl, P. 2008. Age-specific and Lifetime Reproductive Success of Known Age Northern Spotted Owls on Four Study Areas in Oregon and Washington. MS Thesis, Oregon State University, USA.

SAS INSTITUTE, INC. 2008. SAS/STAT 9.2 users guide. SAS Institute, Inc., Cary, NC.

USDA and USDI. 1994. Final supplemental impact statement on management of habitat for late-successional and old-growth forest related species within the range of the northern spotted owl. 2 volumes. U. S. Department of Agriculture - Forest Service and U.S. Department of Interior - Bureau of Land Management, Portland, OR. Irregular pagination.

USDA. 1997. Oregon Eastern Cascades Physiological Province Late Successional Reserve Assessment. U. S. Department of Agriculture - Forest Service, Klamath Falls, OR. 85p.

USDA. 1998. Southern Cascades Late Successional Reserve Assessment. U. S. Department of Agriculture - Forest Service, Roseburg, OR. 254p.

USDI. 2008. Final recovery plan for the northern spotted owl (*Strix occidentalis caurina*). USDI Fish and Wildlife Service, Portland, OR.

USDI. 2010. Draft revised recovery plan for the northern spotted owl, *Strix occidentalis caurina*, U.S. Fish and Wildlife Service. Portland, OR. Xxi + 163 pp.

USFWS (U.S. Fish and Wildlife Service). 2004. Northern spotted owl: Five Year Review Summary and Evaluation. USDI Fish and Wildlife Service, Portland, Oregon. 73 pp

Wiens, J.D., R.G. Anthony, and E.D. Forsman. *In press*. Barred owl occupancy surveys within the range of the northern spotted owl. Journal of Wildlife Management.

Appendix 1. Number of northern spotted owl sites surveyed and their respective occupancy on the Southern Cascades Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 1990-2010[a].

Year	# Sites Surveyed	# Sites w/ Pairs	# Sites w/ Single Owls	# Sites w/ Social Status Unknown[b]	Total Occupied Sites	# of Sites Unoccupied[c]	% Sites Occupied
1990	78	54	6	11	71	7	91
1991	123	81	5	22	108	15	88
1992	138	107	3	14	124	14	89
1993	126	78	9	22	109	17	86
1994	120	80	4	14	98	22	81
1995	97	62	8	14	84	13	87
1996	91	65	4	7	76	15	84
1997	90	58	4	11	73	17	81
1998	91	67	2	8	77	14	85
1999	81	58	7	5	70	11	86
2000	126	55	10	16	81	45	64
2001	149	80	1	18	99	50	66
2002	161	83	11	17	111	50	69
2003	165	91	5	14	110	55	67
2004	165	73	1	17	91	74	55
2005	167	87	7	17	111	56	66
2006	166	76	9	15	100	66	60
2007	168	79	4	11	94	74	56
2008	169	48	10	23	81	88	48
2009	169	57	5	13	75	94	44
2010	170	60	2	17	79	91	46

[a] All sites which were surveyed to protocol; status as determined by protocol (Forsman 1995).
[b] Sites with a response by a male and/or female that did not meet pair or single status with ≥3 night visits.
[c] A minimum of 3 nighttime visits without a response was needed to infer unoccupied status.

Appendix 2. Number of spotted owl sites surveyed to protocol and their respective occupancies by Land-use Allocation on the Southern Cascades Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 1997-2010[a] .

Land-Use Allocation[b]	Year	# Sites Surveyed	# Sites w/ Pairs	# Sites w/ Single Owls	# Sites w/ Social Status Unknown	Total Occupied Sites	# Sites Unoccupied	% Sites Occupied
Matrix								
	1997	28	20	0	4	24	4	86
	1998	24	18	0	1	19	5	79
	1999	20	17	0	2	19	1	95
	2000	38	17	1	5	23	15	61
	2001	46	22	1	5	28	18	61
	2002	50	24	4	7	35	15	70
	2003	52	28	0	6	34	18	65
	2004	53	22	0	8	30	23	57
	2005	53	28	1	5	34	19	64
	2006	53	23	0	4	27	26	51
	2007	53	23	3	2	28	25	55
	2008	53	15	4	8	27	26	51
	2009	53	17	1	2	20	33	38
	2010	53	15	2	4	21	32	40
LSR								
	1997	53	34	3	6	43	10	81
	1998	58	40	2	7	49	9	84
	1999	52	37	6	2	45	78	87
	2000	79	32	9	9	50	29	63
	2001	86	49	0	12	61	25	71
	2002	94	51	6	10	67	27	71
	2003	95	52	4	6	62	33	65
	2004	95	42	0	9	51	44	53
	2005	96	51	4	9	64	32	67
	2006	96	45	8	10	63	33	66
	2007	98	47	1	9	57	41	58
	2008	98	26	5	14	45	53	46
	2009	98	36	2	11	49	49	50
	2010	99	40	0	11	48	51	52
Wilderness								
	1997	9	4	1	1	6	3	67
	1998	9	9	0	0	9	0	100
	1999	9	4	1	1	6	3	67
	2000	9	6	0	2	8	1	89
	2001	17	9	0	1	10	7	59
	2002	17	8	1	0	9	8	53
	2003	18	11	1	2	14	4	78
	2004	17	9	1	0	10	7	59
	2005	18	8	2	3	11	5	71
	2006	17	8	1	1	10	7	59

Cont.

Land-Use Allocation	Year	# Sites Surveyed	# Sites w/ Pairs	# Sites w/ Single Owls	# Sites w/ Social Status Unknown	Total Occupied Sites	# Sites Unoccupied	% Sites Occupied
Wilderness								
	2007	17	9	0	0	9	8	53
	2008	18	7	1	1	9	9	50
	2009	18	4	1	1	6	12	33
	2010	18	5	0	2	7	11	39

[a] See Table 1 for column heading definitions.

[b] See the Northwest Forest Plan (1994) for a description of Matrix and LSR Land-use Allocations.

Appendix 3. Summary of reproductive success of northern spotted owls on the Southern Cascades Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 1990-2010[a].

Year	# Pairs Checked	# Pairs Fledging Young	# Young Fledged	% Pairs Producing Young	Average # of Young/ Successful Pair	Average # of Young/Pair
1990	32	18	26	56	1.44	0.81
1991	44	17	26	39	1.53	0.59
1992	75	55	112	73	2.04	1.49
1993	58	11	16	19	1.45	0.28
1994	70	35	64	50	1.83	0.91
1995	46	14	22	30	1.57	0.48
1996	61	30	45	49	1.50	0.74
1997	46	12	18	26	1.50	0.39
1998	61	32	44	53	1.38	0.72
1999	50	7	12	14	1.71	0.24
2000	49	34	59	69	1.74	1.20
2001	76	11	18	15	1.64	0.24
2002	74	51	96	69	1.88	1.30
2003	82	23	39	28	1.70	0.48
2004	73	56	105	77	1.88	1.44
2005	80	23	31	29	1.35	0.39
2006	74	19	30	26	1.58	0.41
2007	74	41	67	55	1.63	0.91
2008	44	1	1	2	1.00	0.02
2009	53	27	49	51	1.81	0.92
2010	60	29	48	48	1.66	0.80

[a] All sites which were surveyed to reproductive protocol (Forsman 1995).

Appendix 4. Summary of reproductive success for northern spotted owls, by Land-use Allocation, on the Southern Cascades Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 1997-2010[a].

Land-Use Allocation	Year	Number of Pairs Checked	Number of Pairs Fledging Young	Number of Young Fledged	Percentage of Pairs Producing Young	Average Number of Young/ Successful Pair	Average Number of Young/Pair	Mean Fecundity[b], # Females
Matrix								
	1997	17	6	9	35	1.50	0.53	0.264 (17)
	1998	16	10	13	63	1.30	0.81	0.375 (16)
	1999	15	6	10	40	1.67	0.67	0.333 (15)
	2000	14	7	11	50	1.57	0.79	0.393 (14)
	2001	20	4	6	20	1.50	0.30	0.143 (21)
	2002	22	12	24	55	2.00	1.09	0.545 (22)
	2003	23	6	11	26	1.83	0.48	0.229 (24)
	2004	22	18	32	82	1.78	1.46	0.659 (22)
	2005	28	8	10	29	1.25	0.36	0.167 (30)
	2006	22	6	10	27	1.67	0.46	0.217 (23)
	2007	20	11	19	55	1.72	0.95	0.452 (21)
	2008	14	0	0	0	0.00	0.00	0.000 (17)
	2009	17	11	20	65	1.82	1.18	0.556 (18)
	2010	15	7	12	47	1.71	0.80	0.375 (16)
LSR								
	1997	27	6	9	22	1.50	0.33	0.167 (27)
	1998	37	21	30	57	1.43	0.81	0.405 (37)
	1999	32	1	2	3	2.00	0.06	0.031 (32)
	2000	29	23	40	79	1.74	1.38	0.667 (30)
	2001	47	7	12	15	1.71	0.26	0.128 (47)
	2002	45	33	60	73	1.82	1.33	0.667 (45)
	2003	48	15	25	31	1.67	0.52	0.276 (49)
	2004	42	30	58	71	1.93	1.38	0.674 (43)
	2005	45	12	18	27	1.50	0.40	0.202 (47)
	2006	44	12	18	27	1.50	0.41	0.191 (47)
	2007	46	28	45	61	1.61	0.98	0.450 (50)
	2008	23	1	1	4	1.00	0.04	0.020 (25)
	2009	32	14	26	44	1.86	0.81	0.394 (33)
	2010	40	21	32	53	1.52	0.80	0.425 (40)
Wilderness								
	1997	3	0	0	0	NA	0.00	0.000 (3)
	1998	8	2	2	25	1.00	0.25	0.125 (8)

Cont.

Land-Use Allocation	Year	Number of Pairs Checked	Number of Pairs Fledging Young	Number of Young Fledged	Percentage of Pairs Producing Young	Average Number of Young/ Successful Pair	Average Number of Young/Pair	Mean Fecundity[b], # Females
Wilderness								
	1999	3	0	0	0	NA	0.00	0.000 (3)
	2000	6	4	8	67	2.00	1.33	0.667 (6)
	2001	8	0	0	0	NA	0.00	0.000 (8)
	2002	7	6	12	86	2.00	1.71	0.857 (7)
	2003	11	2	3	18	1.50	0.27	0.125 (12)
	2004	9	9	15	100	1.67	1.66	0.833 (9)
	2005	7	3	3	43	1.00	0.43	0.188 (8)
	2006	8	1	2	13	2.00	0.25	0.143 (8)
	2007	8	2	3	25	1.50	0.38	0.188 (8)
	2008	6	0	0	0	0.00	0.00	0.000 (7)
	2009	4	2	3	50	1.50	0.75	0.375 (4)
	2010	5	1	2	20	2.0	0.40	0.200 (5)

[a] All sites which were surveyed to reproductive protocol (Forsman 1995).
[b] Average fecundity estimate = number of female young produced per female owl (assume a 1:1 sex ratio of young at birth).

Appendix 5. Age and sex of northern spotted owls detected on the Southern Cascades Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 1990-2010.

Year	Adults (M,F)	Subadults (M,F)	Age Unknown (M,F)	Age Combined (M,F)	All Juveniles	Subadults (%)	Males (%)
1990	54 (30,24)	2 (1,1)	96 (53,43)	152 (84,68)	26	4	55
1991	112 (58,54)	7 (3,4)	84 (46,38)	203 (107,96)	33	6	53
1992	139 (77,62)	8 (4,4)	97 (46,51)	244 (127,117)	121	5	52
1993	136 (76,60)	12 (5,7)	46 (24,22)	194 (105,89)	16	8	54
1994	139 (73,66)	11 (7,4)	31 (17,14)	181 (97,84)	66	7	54
1995	126 (64,62)	9 (7,2)	16 (12,4)	151 (83,68)	24	7	55
1996	123 (61,62)	5 (4,1)	17 (10,7)	145 (75,70)	46	4	52
1997	114 (63,51)	7 (2,5)	16 (9,7)	137 (74,63)	18	6	54
1998	133 (70,63)	4 (3,1)	22 (14,8)	159 (87,72)	45	3	55
1999	122 (71,51)	7 (1,6)	15 (9,6)	144 (81,63)	12	5	56
2000	111 (65,46)	10 (2,8)	22 (16,6)	143 (83,60)	59	8	58
2001	151 (80,71)	10 (4,6)	25 (20,5)	186 (104,82)	18	6	56
2002	157 (86,71)	13 (5,8)	27 (17,10)	197 (108,89)	98	8	55
2003	168 (90,78)	13 (2,11)	21 (15,6)	202 (107,95)	39	7	53
2004	140 (71,69)	11 (5,6)	23 (15,8)	174 (91,83)	106	7	52
2005	157 (78,79)	19 (11,8)	30 (20,10)	206 (109,97)	32	11	53
2006	145 (78,67)	18 (9,9)	21 (13,8)	184 (100,84)	31	11	54
2007	151 (76,75)	7 (2,5)	20 (13,7)	178 (91,87)	67	4	51
2008	101 (55,46)	7 (2,5)	23 (13,10)	131 (70,61)	1	6	54
2009	115 (60,55)	2 (1,1)	16 (7,9)	133 (68,65)	49	2	51
2010	116 (58,58)	10 (7,3)	22 (13,9)	147 (78, 70)	48	7	53